West Branch of the St. Mary's River Restoration Project
2017 Post Construction Report

Department of Fisheries and Oceans
Small Craft Harbours Branch
August, 2017

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1. Introduction

The St. Mary's River Association (SMRA) is a charitable, non-profit organization with a primary vision to achieve a healthy river ecosystem, salmon population and surrounding community. The SMRA works toward this vision by providing leadership and engaging its partners to enhance, protect, and promote the health of the St. Mary's River. Additionally, the SMRA runs its Interpretive Centre as well as education programs to perform outreach and advance their vision.

The St. Mary's River has long been recognized as one of the most attractive and greatest salmon producing rivers in Nova Scotia. At approximately 250 kilometres, it is one of Nova Scotia's longest rivers, running through Pictou, Antigonish and Guysborough Counties and draining into the Atlantic Ocean near the community of Sonora (Mitchell, 2009). The St. Mary's River also provides riparian habitat which serves as critical habitat and corridors for imperiled wildlife, however, it faces increased pressures from many activities, which impact the river's ecological integrity. It is one of the last salmon rivers on the Atlantic coast of Nova Scotia with substantial runs of 3SW Salmon. That stock has been declining in numbers for decades, along with other salmon stocks in the Atlantic Provinces. Both the commercial and recreational fisheries for salmon on the St. Mary's River are currently closed.

Since 1979, the SMRA has conducted research, monitoring and management projects, collaborating with both government and non-governmental agencies. Examples of successful past projects include the St. Mary's River Forestry/Wildlife Project (1984-1992), a River-Specific Management Program (1985-1994), collaboration with DFO to determine juvenile and adult Atlantic Salmon abundance and distribution (1990-current), and conducting river restoration projects (1995-current). In 2013, the SMRA was involved in developing a comprehensive St. Mary's River Recovery Strategy (Hunter and Mitchell, 2013). The current project addresses some of the recommendations in this Recovery Strategy, specifically on the West Branch of the St. Mary's River, beginning about 600 meters (m) below the entrance of Lower Bryden Brook and ending at Site 7 (see Figure 5 on Page 5).

2. Project Location

The St. Mary's River drains approximately 1,350 square kilometers of land and consists of three branches, the East, West, and North branches, with the Main Branch extending to the estuary (Figure 1). The objective of this project was to conserve, rebuild, and restore the habitat of wild Atlantic Salmon on approximately seven (7) kilometres of the West Branch. The overall restoration project focused on 8 specific sites on the West Branch. Each site required multiple structures to be built in and around the channel, with multiple funding partners in order to achieve the restoration objectives.

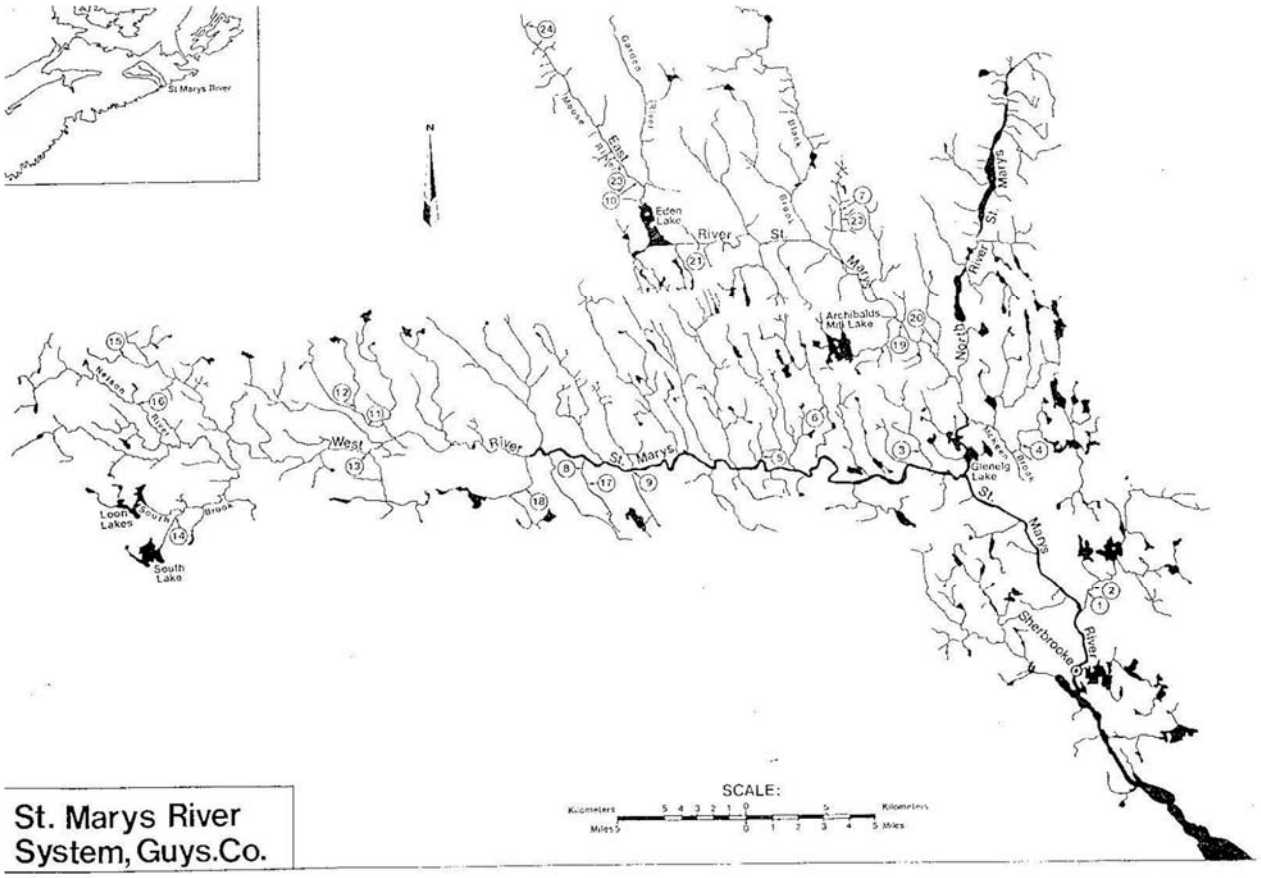

Figure 1: Map of the St. Mary's River watershed, showing the West, East, North and Main Branches

The main contributors to this project included: Fisheries and Oceans Canada (DFO) – Small Craft Harbours Branch (SCH), Atlantic Salmon Endowment Fund (ASEF), Recreational Fisheries Conservation Partnerships Program (RFCPP), as well as Nova Scotia Liquor Commission's Adopt-a-Stream Program. SCH funding supported remedial work on Sites 0, 1, 4, 5, 6 and 7 as a conservation project to improve the productivity of fisheries in order to offset residual impacts associated with its construction program. This amounted to 210,100 m^2 of habitat that will be utilized as offsetting for SCH construction projects in the Maritimes. To date, all in-stream work has been completed for SCH as per its contribution agreement with SMRA.

3. River Conditions

In 2013, the SMRA developed a Salmon Recovery Strategy that identified the need to address the deteriorating habitat resulting from past human activity, acidic precipitation, peak ice conditions, flood events, etc. The Association used this Recovery Strategy as a blueprint to address the habitat issues and create conditions so that all flora and fauna can survive and thrive. This Strategy concluded that there has been significant habitat degradation on the St. Mary's River that has had a negative impact on its salmon habitat. While low readings on the pH scale is a concern on some tributaries, the effects of peak rain and ice events has caused widespread damage along much of the West Branch and various locations on the East and Main Branches of the River (Figure 2).

Figure 2: Ice scour on a tree in the Upper West Branch, St. Mary's River

Particularly on the West Branch, flood events eroded the river banks creating wide, shallow flows along long sections of the river. The hydrology dictates that the bank-full width of the river should be about 30-33 m for the study area; however, it is actually in the order of 60 m. The current, summertime wetted width is 25-45 m, which is double or triple what it should be at this time of year. Additionally, pools make up only about 2 percent of the river in the project area, and are only a maximum of one metre deep; they should make up 25 percent of the river and be at least three meters deep. This summertime, shallow conditions, provide a large surface area that allows the sun to heat the water temperature to levels that make it difficult for juvenile salmon to survive. Not only can the temperature reach lethal levels, but as water levels fall, large portions of river bed are exposed, which often result in the small fish being trapped in small pools and back waters. In the summer of 2014, temperatures reached 28 degrees Celsius at times and many dead and dying fish were observed.

During the fall, with higher water levels, adult salmon may spawn on beach areas. In winter, the water levels decrease, and the wide thalweg freezes to the bottom. Not only can this pose a risk for the salmon eggs deposited in these shallows, but during the spring thaws, when water levels increase, the ice, often floats, lifting the gravel and eggs with it. This can result in additional erosion and gravel being deposited in areas where other salmon eggs may have been laid. Juvenile density data for salmon indicate that population levels are well below conservation targets (Table 1).

Table 1. Juvenile salmon density data from the West Branch of the St. Mary's River from DFO, 2009-2013.

West Branch, St. Mary's River, 2009-2013 Densities fish/100m^2				
Year	**0+ Fry**	**1+ Parr**	**2+ Parr**	**Parr Total**
2009	13.1	2.0	0.0	2.0
2010	6.9	8.3	0.2	8.4
2011	9.8	3.7	0.2	3.9
2012	9.3	5.0	1.3	6.3
2013	2.2	2.9	0.2	3.2

This project implemented the majority of the restoration plan that was developed for the West Branch. To date, the sections requiring work have been identified, the type of work needed has been defined, the cost of work has been determined, funding has been secured and restoration work has been completed. The restoration of the eight sites as identified on Figure 5 required four years of restoration work (2014-2017), and will require three years for monitoring (2016-2019).

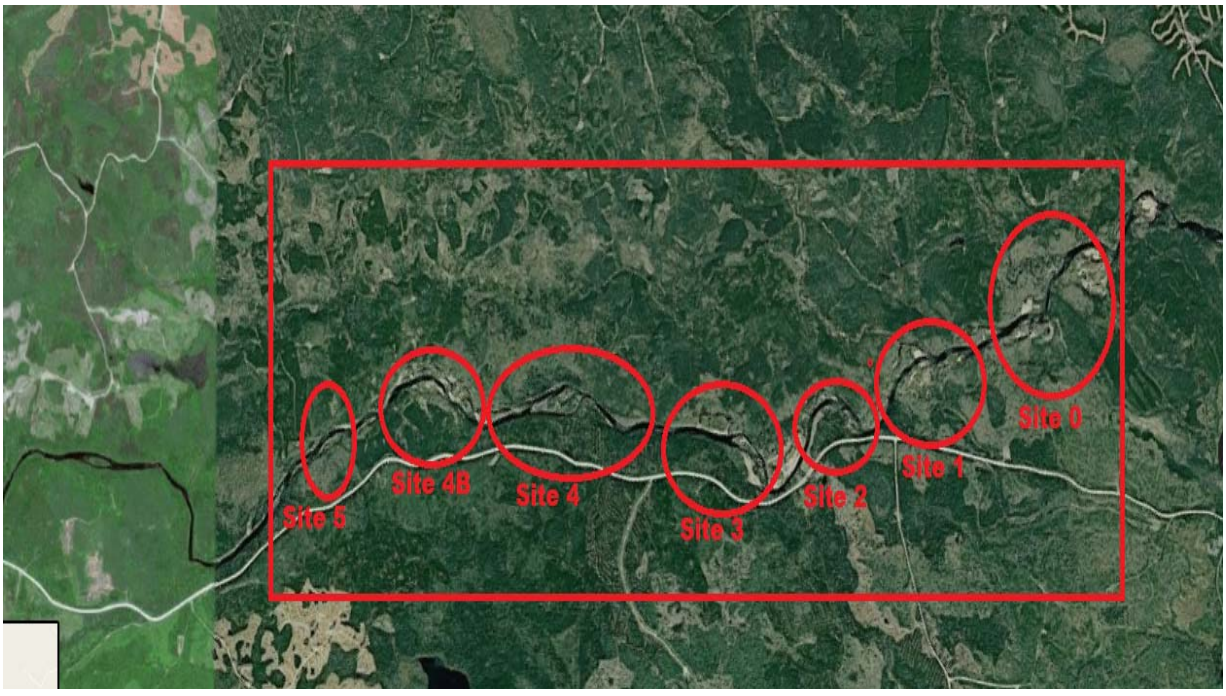

Figure 3: Sites 0 - 5

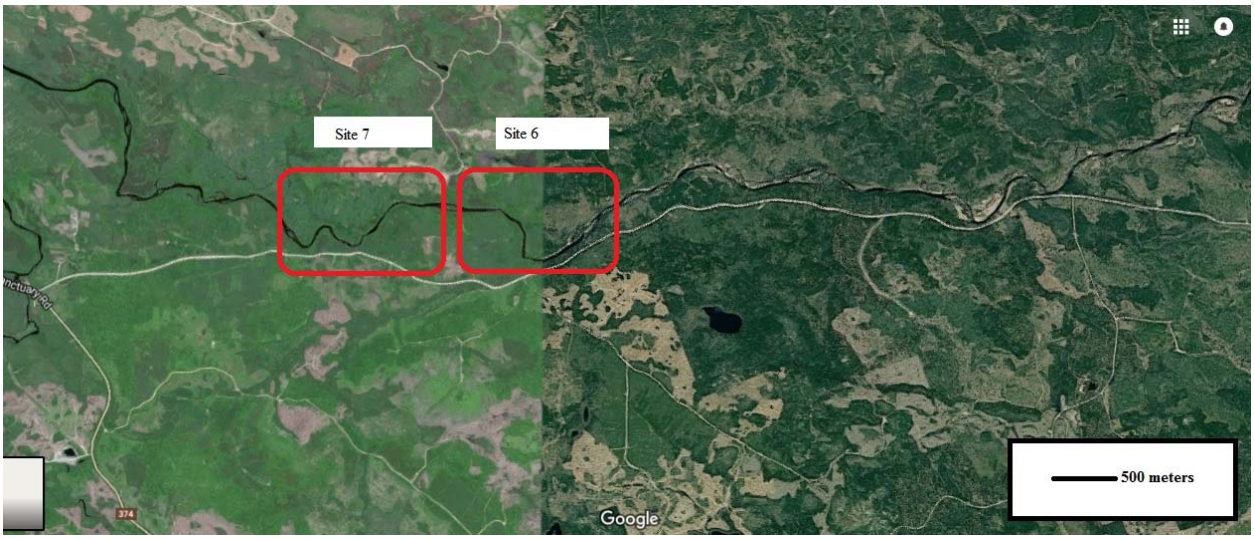

Figure 4: Sites 6 and 7

Figure 5: Restoration area 2014 - 2017

West Branch St. Mary's River: Compensation Summary and Table

Within the project area on the West Branch, eight sites were identified as requiring restoration work (see descriptions and pictures below). Three of the six structures planned for Site 4 were completed and all structures at Site 5 were completed in 2014. Work on Site 1 and the remaining work on Site 4 was completed in 2015. Sites 2, 3 and 4b and were funded (from sources other than SCH) and all of the required work was completed in 2016. Additional work at Site 0 was also completed in 2016. Site 6 and 500 m of Site 7 were completed in 2017.

Below is a table summarizing all restoration work completed on the West Branch. The work was funded by five agencies: Department of Fisheries and Oceans – Small Craft Harbours Program, Nova Scotia Liquor Corporation - Adopt-a-Stream Program, Department of Fisheries and Oceans Canada – Recreational Fisheries Conservation Partnership Program, Atlantic Salmon Conservation Foundation as well as internal funding by SMRA.

Site	**Location**	**Restoration Details**	**Credit Area m^2**
0	Lower Bryden Brook	Completed breech repairs, installed rocks sills, and holding pools	36,300
1	Upper Bryden Brook	Completed holding pool, rock sills and breech repair	40,300
2	MacKay Property	Completed rock sills, groynes and bank protection	36,000
3	PID37582806	Completed, work shifted to other funders	30,000
4	PID37582780	Completed rock sills, channel-blocker and rock work. Additional work, including, 2 channel-blockers, and 4 deflectors were constructed.	27,000
4.B	Cameron Settlement	Completed rock sills, armour rock and groyne structures.	24,000
5	Cameron Settlement	Completed 6 rock sills, bank armour and deflectors	31,500
6	Cameron Settlement	Completed 11 groynes, 5 sills, 8 deflectors and 2 bank repairs	60,000
7	Cameron Settlement	Completed 5 groynes, 3 sills and 4 deflectors	15,000
		Total	**300,100**

Table 1: Square meters of habitat restored calculated by the linear length (measured on site) multiplied by the hydrological design width (30 m). This methodology was used and accepted by all funding agencies associated with the project.

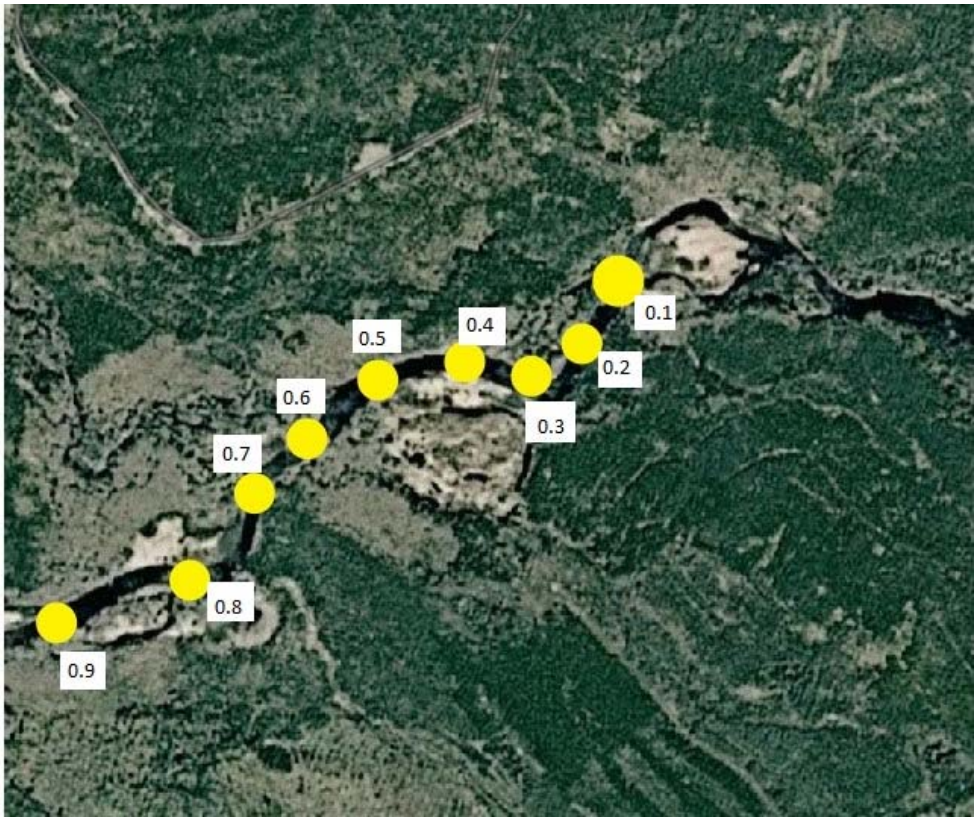

Figure 6: Site 0 with structures labeled

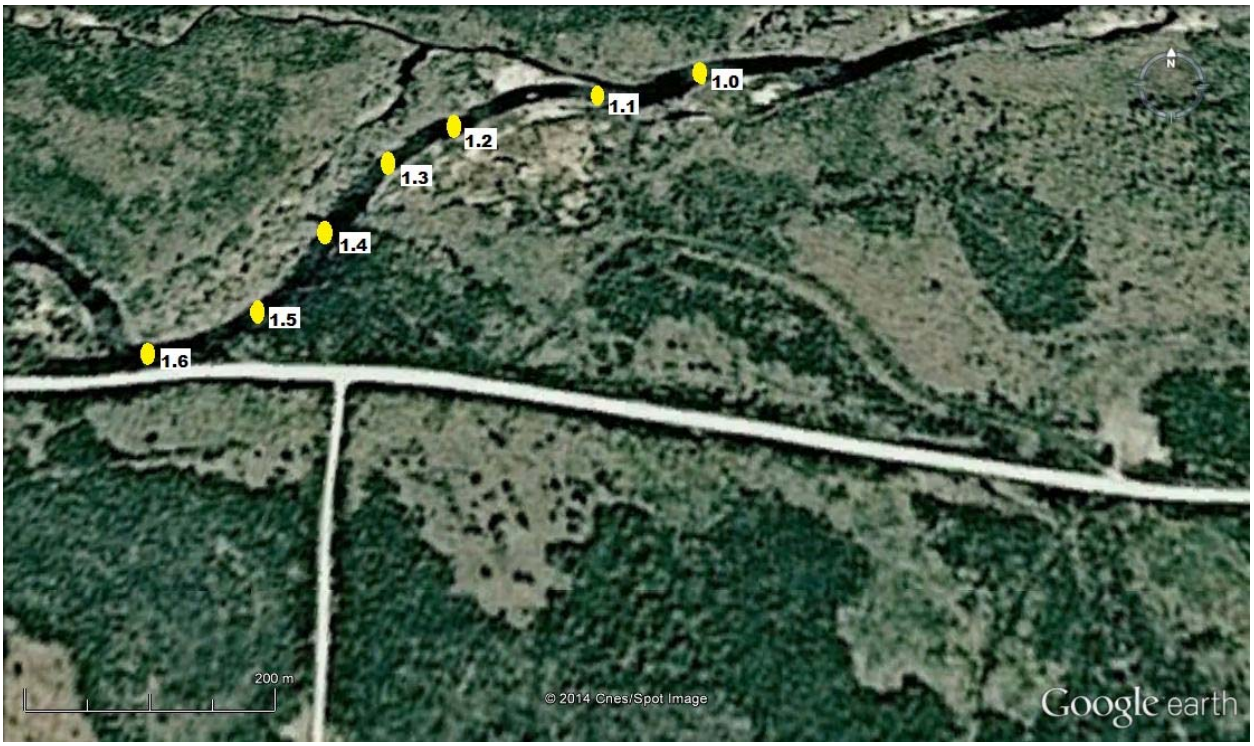

Figure 7: Site 1 with structures labeled

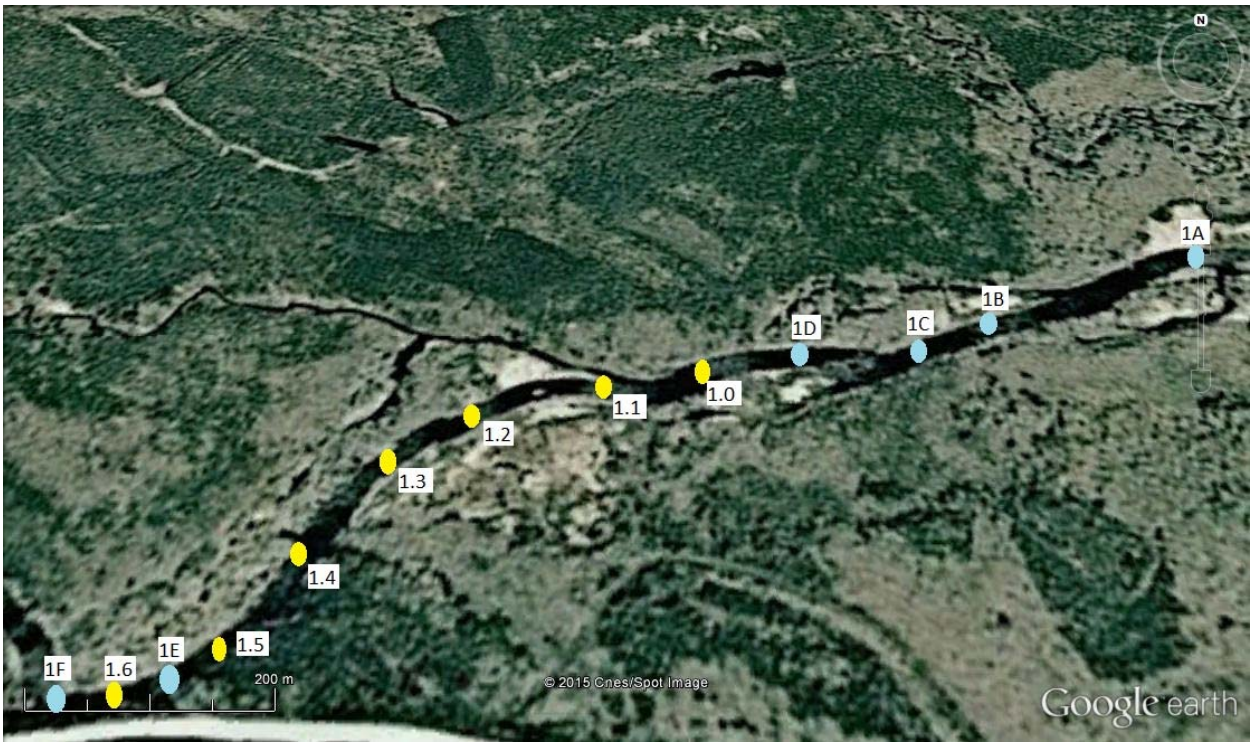

Figure 8: Updated Site 1 plan (all labelled structures are complete). Yellow dots were in the original plan and blue dots are the new structures.

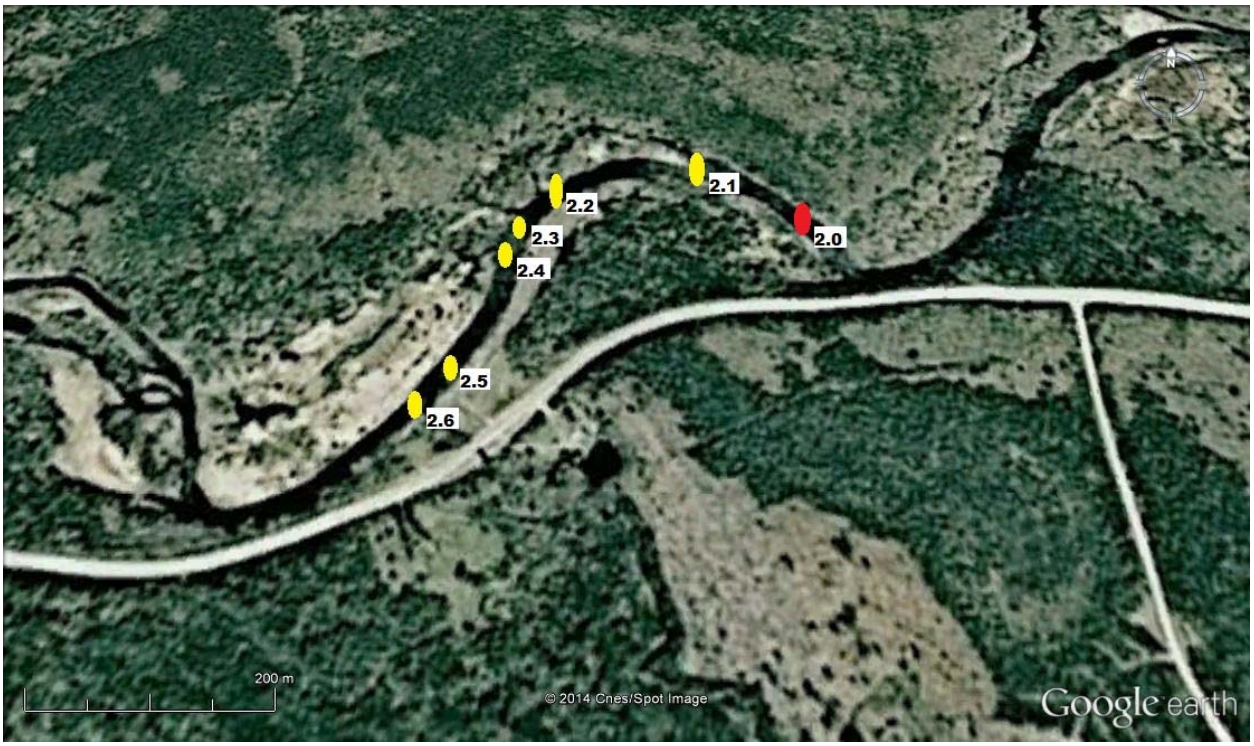

Figure 9: Site 2 with completed (yellow) and planned (red) structures labeled.

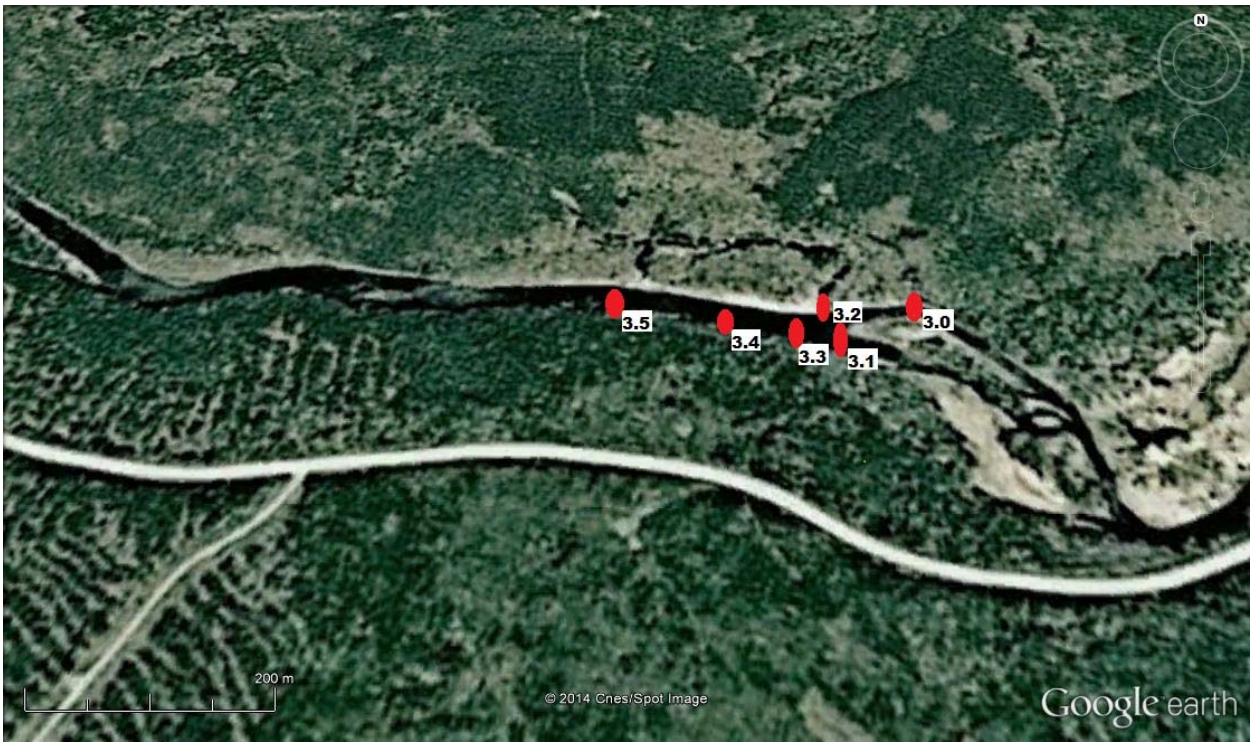

Figure 10: Site 3 with planned structures labeled. Completed in September 2016.

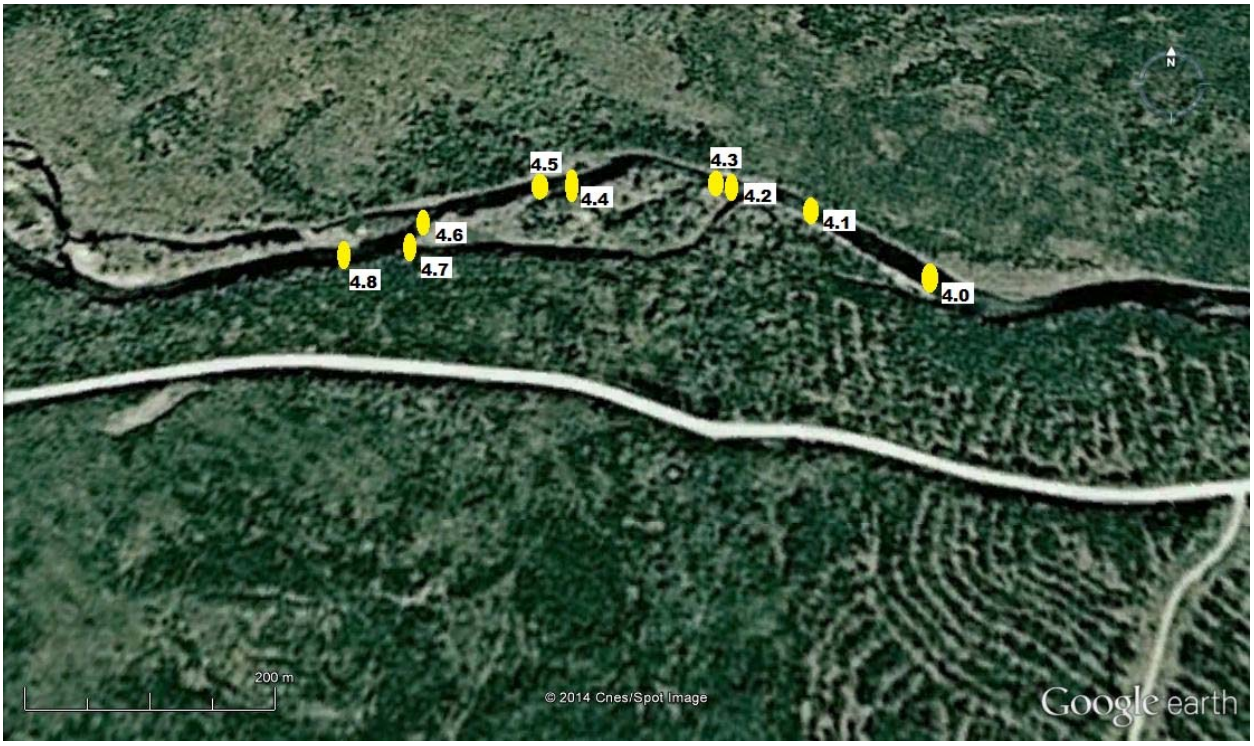

Figure 11: Site 4 with structures labeled.

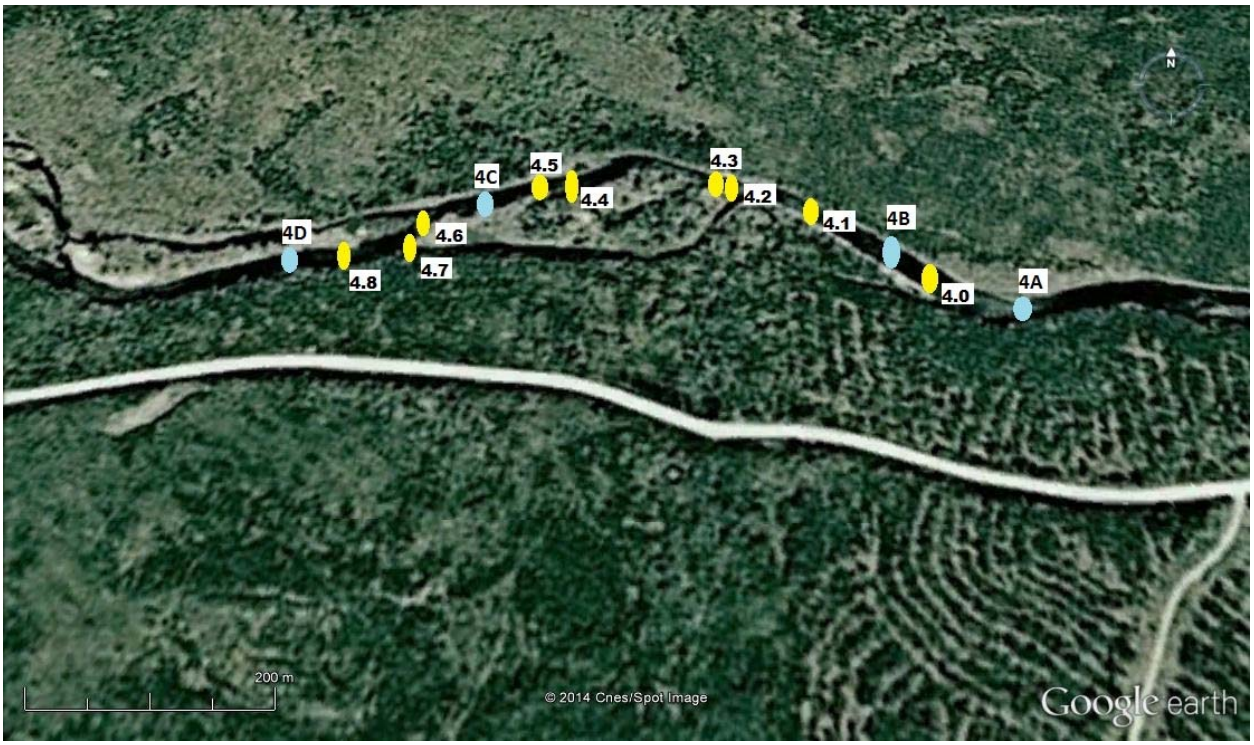

Figure 12: Updated Site 4 plan (all labelled structures are complete). Yellow dots were in the original plan and blue dots are the new structures built in 2015.

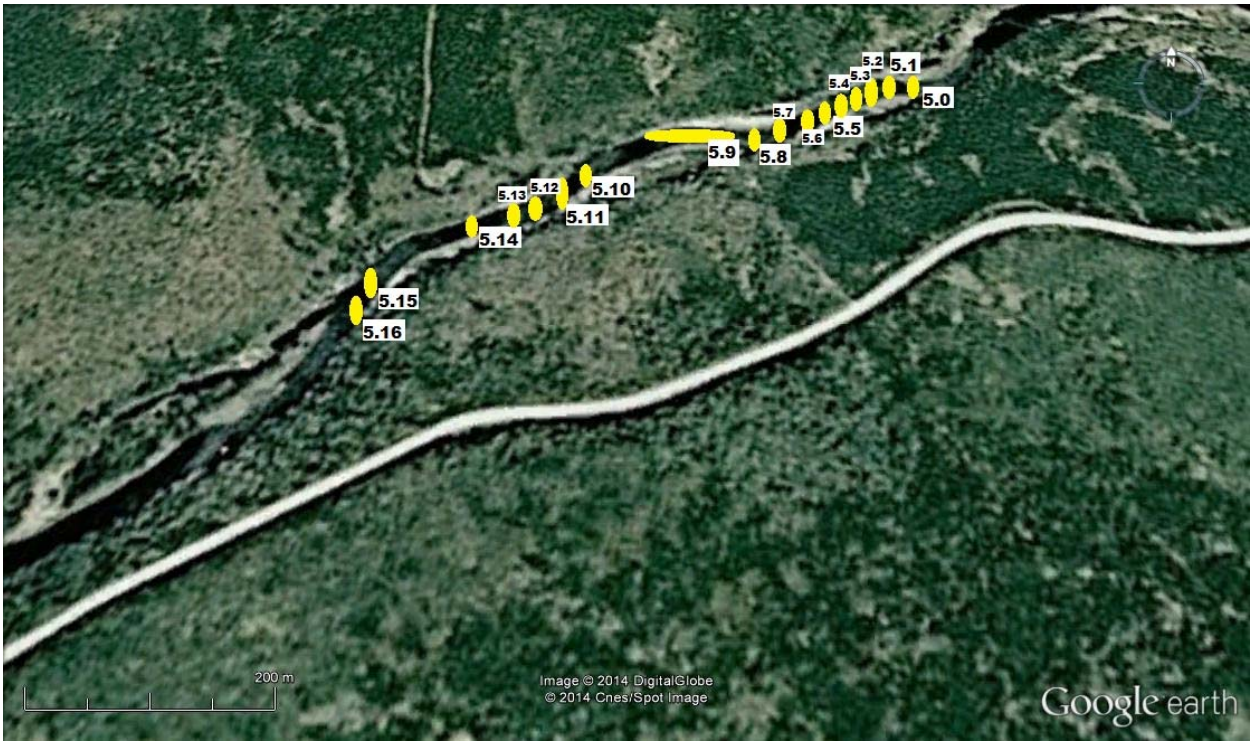

Figure 13: Site 5 with structures labeled.

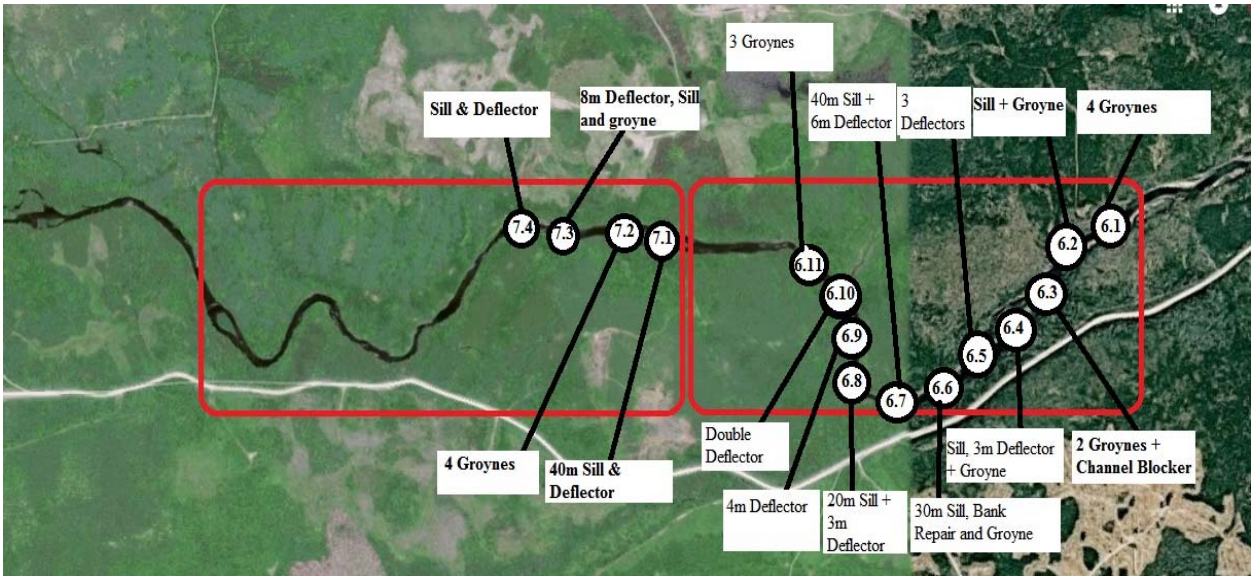

Figure 14: Site 7 and Site 6 with labeled structures.

4. Project Components

The following table is derived from Table 1 for this project and indicates the credits assigned to the Small Craft Harbours Program.

Table 2. Habitat credits for Small Craft Harbours associated with this project.

Site	Location	Restoration Details	Credit Area m^2
0	Lower Bryden Brook	Completed breech repairs installed rocks sills and holding pools	36,300
1	Upper Bryden Brook	Completed holding pool, rock sills and breech repair	40,300
4	PID37582780	Completed rock sills, channel-blocker and rock work. Additional work, including, 2 channel-blockers, and 4 deflectors were constructed.	27,000
5	PID37582749	Completed 6 rock sills, bank armour and deflectors	31,500
6	Cameron Settlement	11 Groynes, 5 sills, 8 deflectors, 2 bank repairs.	60,000
7	Cameron Settlement	5 groynes, 3 sills, 4 deflectors	15,000
		Total	**210,100**

The following table (Table 3) catalogs the structures that were installed at each site funded under the SCH program. The cataloged structures correspond to the labeled maps in Section 3. The table below also provides information on the pre-restoration river conditions and the type of enhancement structures used in the restoration.

Table 3: Enhancement work undertaken on the St. Mary's River.

Site	Coordinates	Prior River Conditions	Enhancement Structures
SITE 0 (Work completed in 2016)			
0.1	62.513326 E 45.291537 N	Split channel	Breech repair with armour rock
0.2	62.512558 E 45.291878 N	Over widened channel and no pools	Rock sill
0.3	62.511225 E 45.292362 N	Split channel and breech	Breech repair with armour rock
0.4	62.510531 E 45.292162 N	Over widened and no pools	Rock sill
0.5	62.509893 E 45.292589 N	Over widened channel	Four rock groynes
0.6	62.509892 E 45.293214 N	Over widened channel and no pools	Rock sill
0.7	62.509448 E 45.293668 N	Over widened channel	Two rock groynes
0.8	62.597940 E 45.294833 N	No pools	Rock sill

Site	Coordinates	Prior River Conditions	Enhancement Structures
0.9	62.505046 E 45.255003 N	Over widened channeland no pools	Paired deflector with sill
Site 1 (Work completed in 2015)			
1A	00538316 E 05015519 N	Over widened channel	4 groynes
1B	00538090 E 05015431 N	Over widened channel, lack of pools and bedrock	Sill and a deflector
1C	00537978 E 05015381 N	Over widened channel	2 groynes
1D	00537836 E 05015381 N	Over widened channel and bank erosion	Deflector and bank protection
1E	00537338 E 05015048 N	Over widened channel and bank erosion	3 deflectors, 4 groynes and bank protection
1F	00537233 E 05015016 N	Over widened channel	Deflector
1.0	00537756 E 05015352 N	Over widened channel, lack of pools and bank erosion. Numerous bedrock outcrops.	Where the access road meets the river, extensive bank protection and groynes
1.1	00537624 E 05015123 N	Wide channel, lack of pool and bank erosion	35 m rock sill and bank protection at Upper Bryden Brook outlet
1.2	00537501 E 05015090 N	Over widened channel and lack of pools	Sill approximately 125 m upstream from the sill at 1.1
1.3	00537461 E 05015066 N	Bank erosion	Bank protection
1.4	00537404 E 05015035 N	Bank erosion	Bank protection and deflector, also bank cut back and sloped at the lower end
1.5	00537362 E 05014953 N	Braided channel	Channel-blocker. Added 3 deflectors, 4 groynes, and bank protection
1.6	00537256 E 05014826 N	Over widened channel, lack of pools and numerous bedrock outcrops	Sill and deflector
SITE 4 (Structures 4.2, 4.3, 4.4, 4.5 completed in 2014, remaining structures completed 2015)			
4A	00535708 E 05015025 N	Over widened channel	Deflector
4B	00535549 E 05015101 N	Over widened channel	2 deflectors
4C	00535119 E 05015149 N	Over widened channel and lack of pool	Sill
4D	00534912 E 05015063 N	Channel breech and over widened channel	2 deflectors and 2 channel-blockers
4.0	00535355 E 05014937 N	Over widened channel, lack of pool and bedrock outcrops	Rock sill and deflector. Added 3 deflectors to this area as well
4.1	00535477 E 05014889 N	Over widened channel, lack of pool and bank erosion	3 deflectors
4.2	00535213 E 05014988 N	Bank erosion	Sill and bank protection
4.3	00535174 E 05014966 N	Braided channel	Sill and channel-blocker
4.4	00535148 E 05014968 N	Channel breech	Breech repair
4.5	00535146 E 05014967 N	Over widened channel and lack of pool	Sill

Site	Coordinates	Prior River Conditions	Enhancement Structures
4.6	00535021 E 05014916 N	Over widened channel, lack of pool and bank erosion	Sill and 20 m of bank protection. Added additional sill in this area.
4.7	00535002 E 05014878 N	Braided channel	Large channel-blocker (8-10 m wide base, 1.4 m high, 4:1 slope, 30 m long)
4.8	00534895 E 05014877 N	Over widened channel, lack of pool and bank erosion	40 m sill, bank protection below and above (about 40 m total) and a vertical kicker Added 2 deflectors and 2 channel-blockers
SITE 5 (Work complete in 2014)			
5.0	00533997 E 05014850 N	Over widened channel and lack of pool	Sill (furthest downstream)
5.1	00534005 E 05014884 N	Bank erosion	Bank protection
5.2	00533988 E 05014883 N	Braided channel	Channel-blocker
5.3	00533965 E 05014880 N	Bank erosion	Deflector and bank protection
5.4	00533941 E 05014871 N	Bank erosion	Deflector
5.5	00533921 E 05014844 N	Over widened channel, lack of pool, and braided channel	Sill and channel-blocker
5.6	00533891 E 05014830 N	Braided channel	Channel-blocker
5.7	00533871 E 05014821 N	Bank erosion	Bank protection and kicker
5.8	00533814 E 05014800 N	Wide channel, lack of pool, and unstable bank	Sill (added 5m of bank protection next year)
5.9	00533786 E 05014791 N	Bank erosion and undefined curve in the river	Bank protection installed and re-profiled the curve
5.10	00533661 E 05014768 N	Over widened channel and lack of pool	Sill (1-1.5 m pool has developed below sill)
5.11	00533629 E 05014715 N	Bank erosion	Bank protection
5.12	00533626 E 05014701 N	Bank erosion	Deflector
5.13	00533611 E 05014691 N	Channel breech	Breech repaired
5.14	00533575 E 05014683 N	Over widened channel, lack of pool, braided channel and bank erosion.	Sill, channel-blocker, bank protection and deflector
5.15	00533420 E 05014617 N	Over widened channel, lack of pool and bank erosion	Sill and a small deflector (1.6m pool has developed below sill)
5.16	00533445 E 05014603 N	Braided channel	Channel-blocker
Site 6 (Work Completed in 2017)			
6.01	00551689 E 05002190 N	Over widened channel and no pools	Groyne
6.02	00551635 E 05002123 N	Over widened channel and no pools	Groyne
6.03	00551633 E 05002312 N	Over widened channel and scoured stream bed	Groyne
6.04	00551667 E 05002112 N	Over widened channel	Groyne

Site	Coordinates	Prior River Conditions	Enhancement Structures
6.05	00551667 E 05002101 N	Over widened channel and lack of pool depth	Sill and groyne
6.06	00551651 E 05002090 N	Braided channel	Channel-blocker
6.07	00551635 E 05002089 N	Over widened channel	Groyne
6.08	00551628 E 05002078 N	Over widened channel	Groyne
6.09	00551628 E 05002045 N	Lack of pools, straight and over widened channel	Sill and 3 m deflector
6.10	00551612 E 05002067 N	Over widened channel	Groyne
6.11	00551588 E 05002056 N	Straight and over widened channel	Deflector
6.12	00551589 E 05002045 N	Over widened channel and no pools	Deflector
6.13	00551576 E 05001589 N	Lack of meander, no pools and over widened channel	Deflector
6.14	00551522 E 05001566 N	No pools, lack of pool depth and scoured stream bed	Sill (30 m)
6.15	00551482 E 05001577 N	Bank erosion and over widened channel	Bank repair / groyne
6.16	00551412 E 05001577 N	Straightened channel and lack of pools	40 m sill and 6 m deflector
6.17	00551462 E 05001577 N	Straight and over widened channel	20 m sill and 3 m deflector
6.18	00551439 E 05002121 N	Lack of pools and over widened channel	4 m deflector
6.19	00551069 E 05002152 N	Over widened channel	Double deflector
6.20	00551045 E 05002162 N	Over widened channel	Groyne
6.21	00551037 E 05002162 N	Over widened channel	Groyne
6.22	00551030 E 05002162 N	Over widened channel and scoured stream bed	Groyne
Site 7 (Work Completed in 2017)			
7.01	00551014 E 05002151 N	Lack of pools, straight and over widened channel	40 m sill and deflector
7.02	00550998 E 05002151 N	Bedrock	Paired groyne
7.03	00550983 E 05002151 N	Bedrock and scoured stream bed	Pair groynes (2 m each)
7.04	00550967 E 05002161 N	Over widened channel	Groynes (10 m)
7.05	00550959 E 05002162 N	Straight channel and no pools	8 m deflector
7.06	00550904 E 05002161 N	Scoured stream bed and no pools	Sill
7.07	00550888 E 05002161 N	Over widened channel	Groyne

Site	Coordinates	Prior River Conditions	Enhancement Structures
7.08	00550880 E 05002161 N	Over widened channel, no pools and no meander pattern	6 m groyne
7.09	00550872 E 05002161 N	Lack of pools	8 m deflector
7.10	00550841 E 05002172 N	Over widened channel	Deflector
7.11	00550754 E 05002171 N	Scoured stream bed and no pools	Sill (30 m)

Descriptions of Structures Used in Restoration

The structures used in this restoration project are described below. The purpose of this restoration project include stabilizing banks in some areas and blocking back channel breeches, narrowing the channel and creating pool-riffle habitat. Most of the degradation on the West Branch of the St. Mary's River has been caused by past farming, forestry and log driving and ice scour of the river bed and banks. This river system has a low to moderate gradient (0.3 - 0.8 percent).

Rock Sills

Rock sills support the riffle upstream of the structure and dig pools on the downstream side (DFO, 2006) (Figure 9). They can also be constructed with deflectors and side sloping for the purpose of narrowing and deepening rivers that have become over-widened and shallow (DFO, 2006, Kennebecasis Watershed Restoration Committee, 2013). Rock sills act much like digger logs, however, digger logs are used in small streams where rock sills can be used in large rivers. These structures will blend into the natural flow of the river after they have been constructed (Kennebecasis Watershed Restoration Committee, 2013). Additionally, rock sills act as gradient controls (DFO, 2006).

Rock sills are constructed at the head of a pool, every six channel widths and on alternating sides of the river. Rocks used should be double the size of the largest boulders in the stream. Sills should be rotated 30 degrees from straight across when looking downstream, towards the desired pool location (DFO, 2006). Rock sills are combined with other in stream structures (i.e., bank armouring, deflectors, etc.) to achieve desired results.


Rock Sills
Rock Groynes

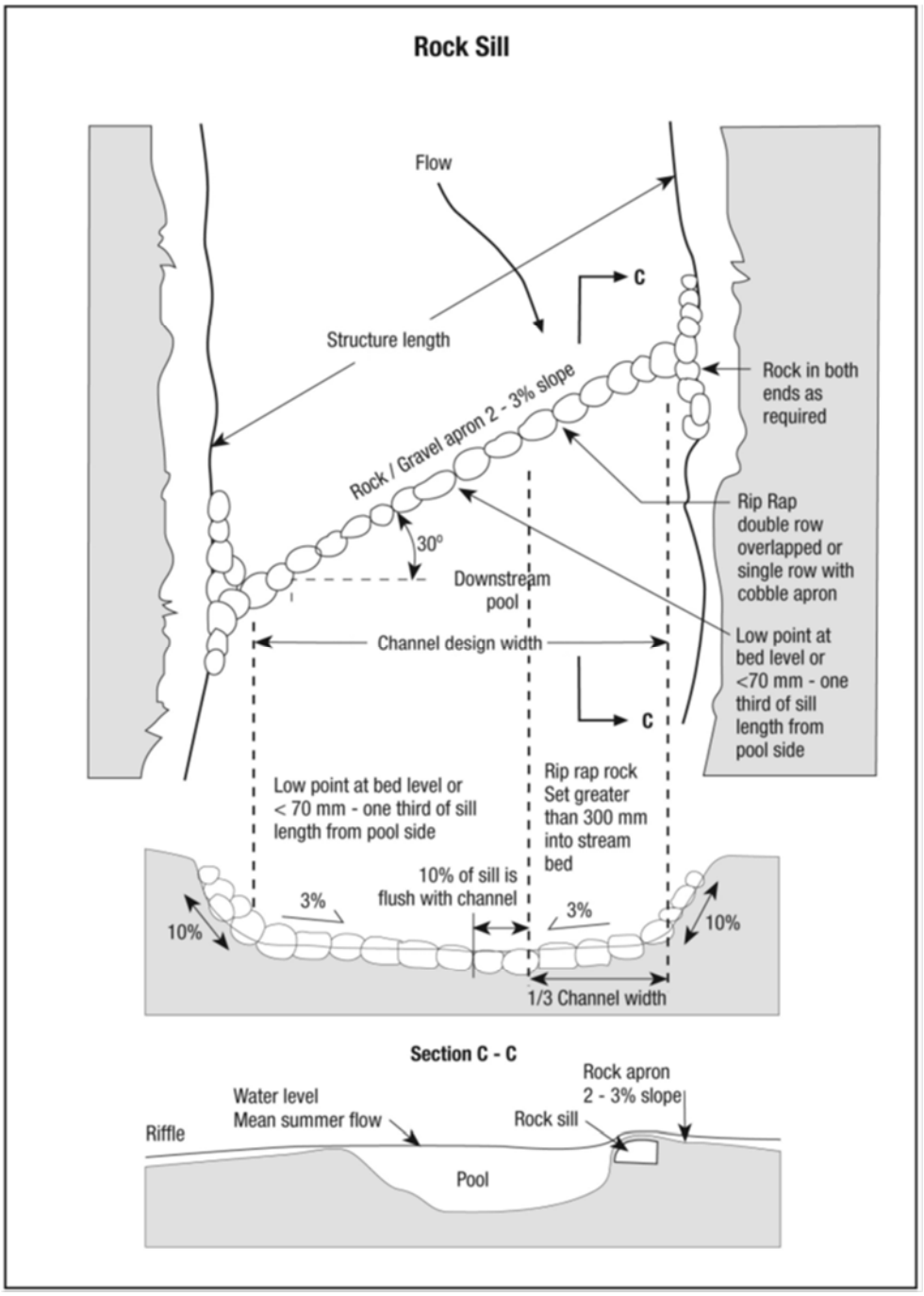

Figure 15: Adapted from DFO, 2006.

Deflectors or Groynes

Deflectors or groynes are similar to constructing a rock sill, but only part way across the river channel (Figure 10). They serve to deflect water away from eroding banks and are often coupled with bank protection on the opposite bank. Sediment will collect around and between deflectors to further stabilize the bank (Kennebecasis Watershed Restoration Committee, 2013).

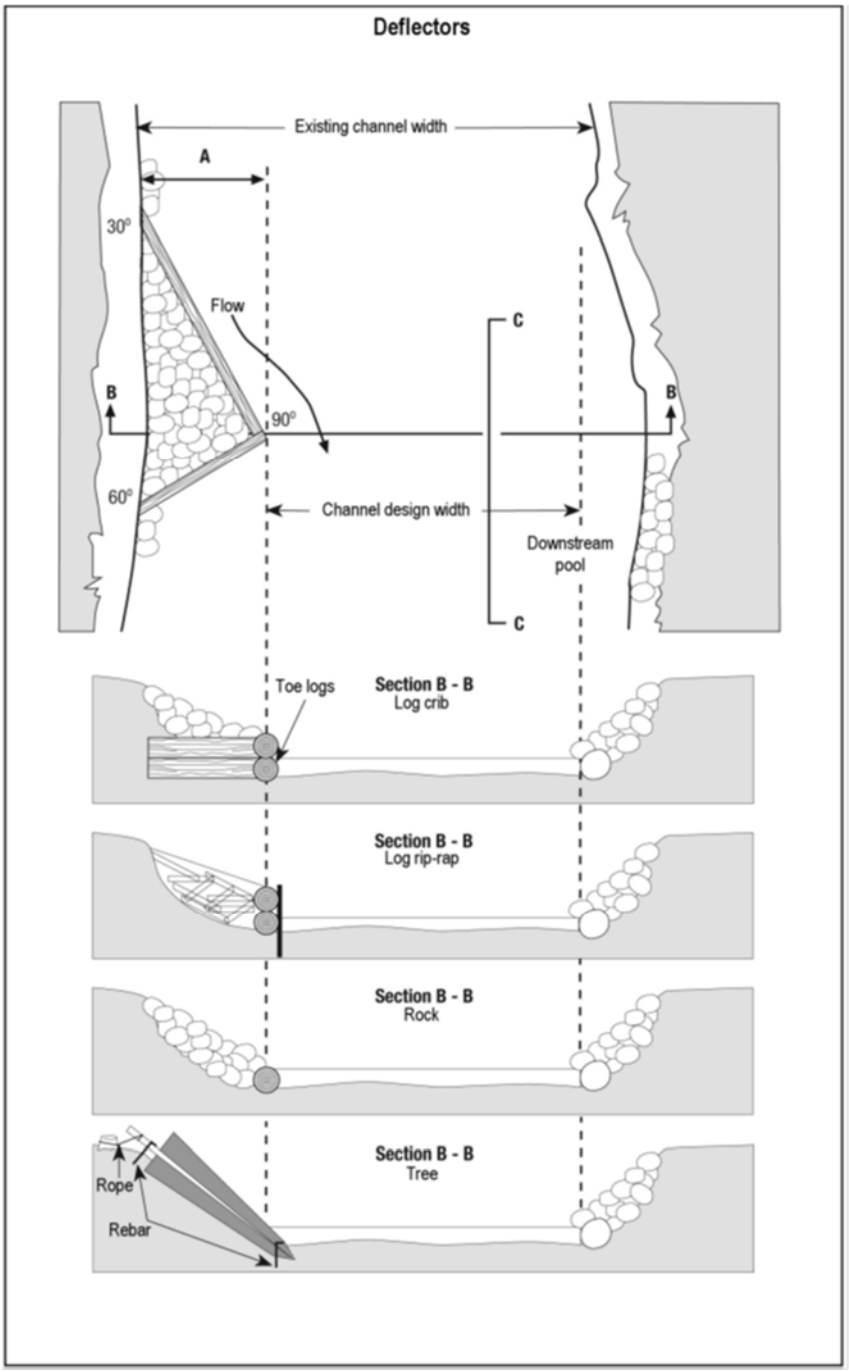

Figure 16: Adapted from DFO, 2006.

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Armour Rocking for Bank Protection or Stabilization

Bank protection or stabilization is utilized on eroding banks with little bank vegetation. Bank protection will also prevent sediment and nutrients from washing into the water course from the bank (Kennebecasis Watershed Restoration Committee, 2013). Very large armour rocks are used to key in the structures and stabilize the bank (Figure 11 and 12).

Figure 17: Bank protection installed at Site 5.

Figure 18: Example of two tonne rock used at Site 4 for bank protection.

Figure 19: Aerial photograph of armour rock bank.

Kickers

Kickers and strategically placed boulders are used to create habitat instream and to reduce bank erosion. As you can see in Figure 13, the kickers are used in conjunction with bank protection.

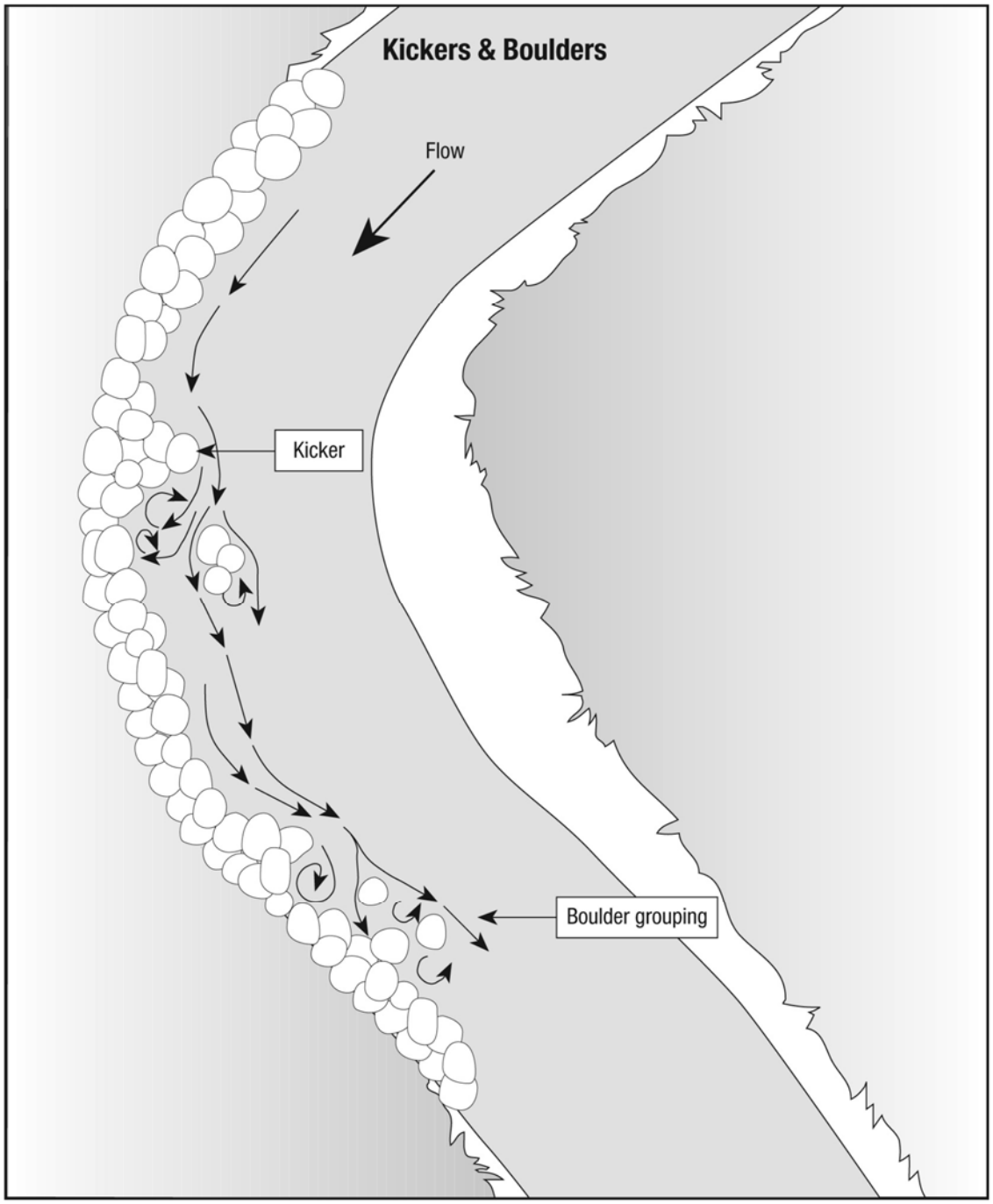

Figure 20: Adapted from DFO, 2006.

Channel-blockers

Channel-blockers are constructed in areas where there has been a channel breech, causing the river to become unnaturally braided or producing back channels. Channel-blockers will block those areas where the channel has been breached and the structure will tie into the bank on either side for stability. The blocker should contain a 1 in 2 year flood so that the bank full discharges will still reach the floodplain. Each channel-blocker is custom designed to fit the restoration needs (see Figure 14 below for an example of a channel-blocker).

Before and After Pictures

Figure 21: Before photo at Site 1. Bryden Brook entrance.

Figure 22: After picture, Site 1. Bryden Brook entrance.

Figure 23: Conceptual design of restoration work on Site 6.

Figure 24. A) Before photo where sill is to be constructed and bank protection is needed (looking at the right bank, facing downstream). B) After photo looking upstream at sill and bank protection.

Figure 25: Before and After, armour rock Site 5.

Figure 26: A) Before shot of the pool below sill 2 at Site 5 (structure 5.5). B) This is the bank work below sill two (structures 5.5 to 5.7). Note the 4:1 slope on the bank instead of the normal 2:1 slope. This will assist in the planting of native trees and grasses later.

Figure 32: Site 6, Structure 13. Rock deflector

Figure 33: Site 7, structure 2 - rock sill

2017 Work: Sites 6 and 7:

Figure 27: Site 6 (See reference point 6.4 from Figure 14).

Figure 28: Site 6, structure 6.09 during construction.

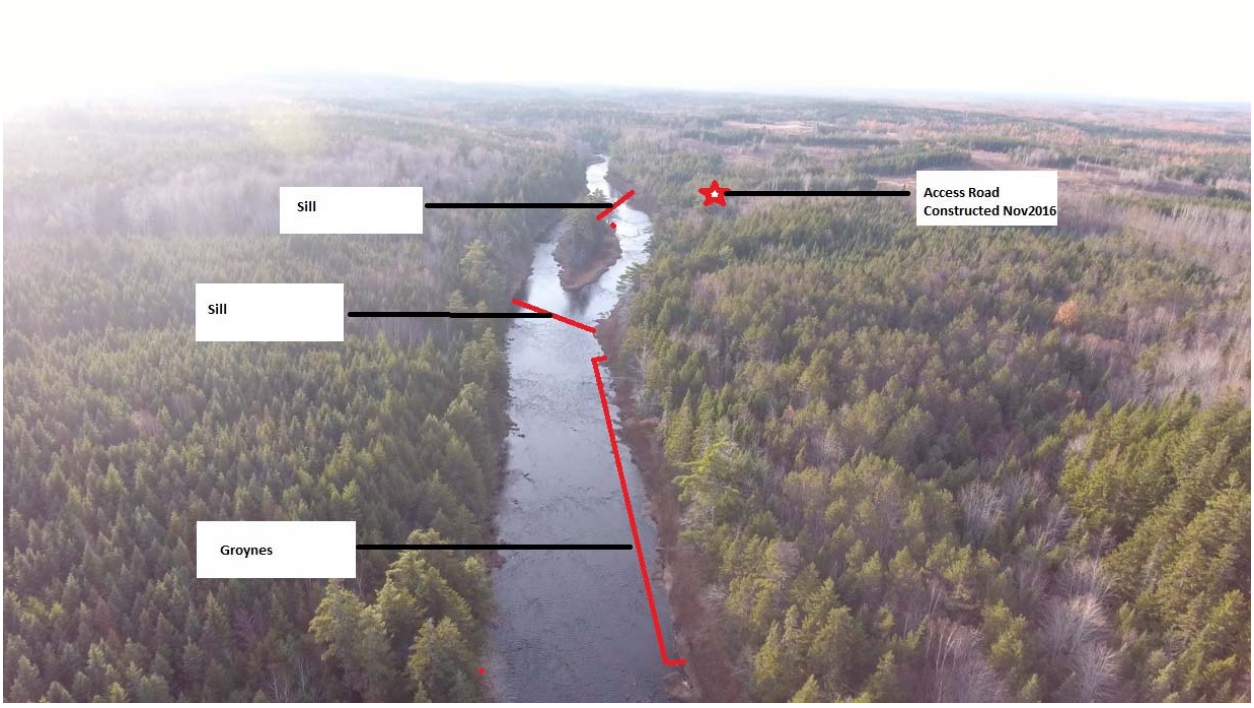

Figure 29: Upper section of Site 6.

Figure 30: An example of degraded habitat from Site 7. Stream bed comprised exclusively of bedrock.

Figure 31: Ice Production Site 7, caused by an over widened channel.

Long term benefits to ecosystem:

Figure 31: Aerial photo, taken prior to 2016 work. Site 5 is at top of picture. Site 4b is below.

5. Monitoring Requirements

Baseline data on river conditions has been recorded by SMRA (Hunter and Mitchell, 2013) and by DFO (juvenile salmon data). Monitoring will occur for three years: 2016, 2017 and 2018 following completion of the restoration work to see if river conditions improve due to restoration efforts. Pre-restoration photos have been recorded for the SMRA. Photos post-restoration are being recorded as work is completed.

Since the beginning of restoration work in 2014, changes have already been observed. There are now 5 cold water sites (Upper, and Lower Bryden Brook, springs entering the river at Site 4, and Crooked Brook), the thalweg is deepening, there are pools developing below all of the new sills, and salmon were observed spawning in the falls of 2014 and 2015.

The monitoring will be conducted as outlined in the October 2016 Monitoring Plan previously submitted to SCH and is as follows:

Year 1 of Monitoring (2016) - Report date March 31, 2017

Physical Monitoring

- Drone flight data analysis to determine changes in number and size of pools in 2014 and 2015 and 2016 restoration sites.
- Temperature probe data analysis to determine changes in pool and run temperature profiles post restoration. 14 probes

Biological Monitoring

- Redd counts from Site 0 to 5

Year 2 of Monitoring (2017) - Report Date March 31, 2018

Physical Monitoring

- Temperature probe data analysis to determine changes in pool and run temperature profiles post restoration. 14 probes

Biological Monitoring

- Electrofishing of selected restored site to determine species abundance. The Zippen electrofishing method will be used.
- Redd counts from Site 0 to Site 7

Year 3 of Monitoring (2018)- Report Date March 31, 2019

Physical Monitoring

- Drone flight data analysis to determine changes in number and size of pools in 2014 and 2015 and 2016 restoration sites.
- Embeddedness, wetted width, channel width and depth field measurements at all structures.
- Temperature probe data analysis to determine changes in pool and run temperature profiles post restoration. 14 probes

Biological Monitoring

- Electrofishing of selected restored site to determine species abundance. The Zippen electrofishing method will be used.
- Redd counts from Site 0 to Site 7.

The data will be collected at comparable times of year starting 2016 and annually until fall 2018. It is important that this assessment be done during or after periods of acceptable flow conditions. The gauge on the main river will be used to ensure data is collected at comparable flows. The reason for this is two-fold; electrofishing done during periods of summer low flows and higher temperatures are likely to be an underestimation of fish populations and contribute to high mortality rates of sampled fish. Additionally channel forming flows; considered to be 1 in 2 years flood levels, are required on restoration structures to produce the desired changes in channel morphology. Drone flights will be done once these channel forming flows have occurred.

A report with compiled data will be submitted each year by March 31, the final year of data collection (2018) will include an assessment of the overall success of the off-setting with a comparison to pre-restoration state of the river.

6. References

DFO. (2006). Ecological Restoration of Degraded Aquatic Habitats: a Watershed Approach. Gulf Region Publication. 180pp.

Hunter, K. and Mitchell, S. 2013. St. Mary's River Association Recovery Strategy. St. Mary's River Association.

Kennebecasis Watershed Restoration Committee. (2013). http://www.kennebecasisriver.ca.

Mitchell, S. 2009. St. Mary's River Hydrology. St. Mary's River Association Technical Report #001.